

# UK Patent Application GB 2 210 714 A

(12)

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(43) Date of A publication 14.06.1989

(21) Application No 8830317.7

(22) Date of filing 28.06.1985

Date lodged 28.12.1988

(30) Priority data

(31) 626339

(32) 29.06.1984

(33) US

(62) Derived from Application No. 8516417.6 under Section 15(4) of the Patents Act 1977

(51) INT CL\*

G06F 15/16 15/21

(52) UK CL (Edition J)  
G4A AFGDX

(56) Documents cited

EP 0069438 A2

Proceedings of the 8th International Conference on Very Large Data Bases; 1982; Arie Shoghani; "Statistical databases: characteristics, problems, and some solutions" pp208-221 especially Example 2 pp209-212 and article 3.3, summary sets, p214, published by VLDB Endowment 1982

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(58) Field of search

UK CL (Edition J) G4A AFGDX AFGN AMP AUD  
INT CL\* G06F  
WPIL (on-line); INSPEC (on-line); U.S. claims (on-line)

## (54) Displaying, processing and displaying financial information

(57) A data processing and communication system distributes and displays financial market ticker, quotation, news and ancillary information via a plurality of stored program controlled work stations. Stock trade executions, quotations and other ticker plant information is communicated in parallel to a hierarchy of system data processing terminals, e.g., those located at area, branch and individual work station locations. Storage media at the several system data processing levels extracts and stores data base information of differing purport and completeness for the disseminated data to support the system work station users. Information characterizing a dynamically changing sub-population of the overall ensemble of market securities is maintained at and becomes immediately available to each work station responsive to the pattern of usage at that specific station. Various derivative tasks, such as security price limit alerts, are user programmable and are activated by the contents of the work station data base.

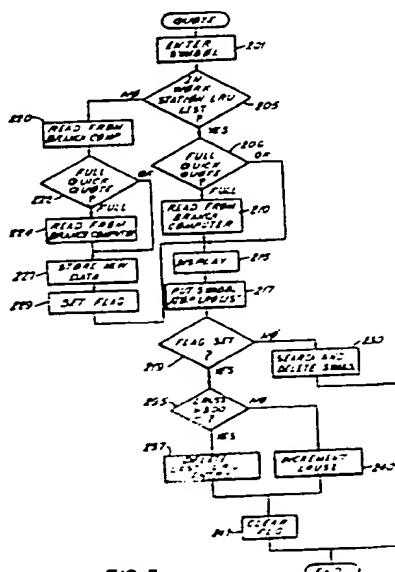


FIG. 3

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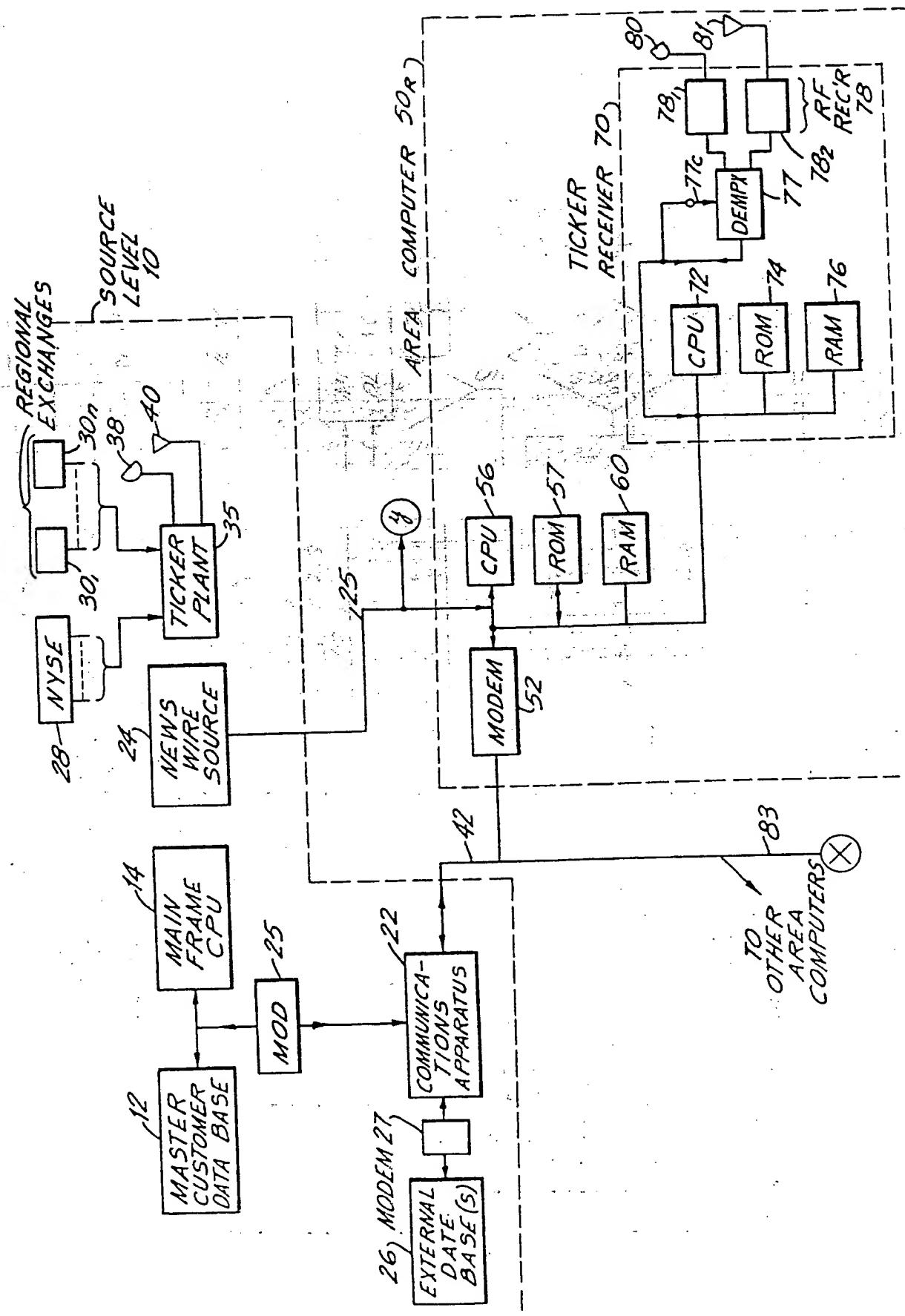


FIG. 1A

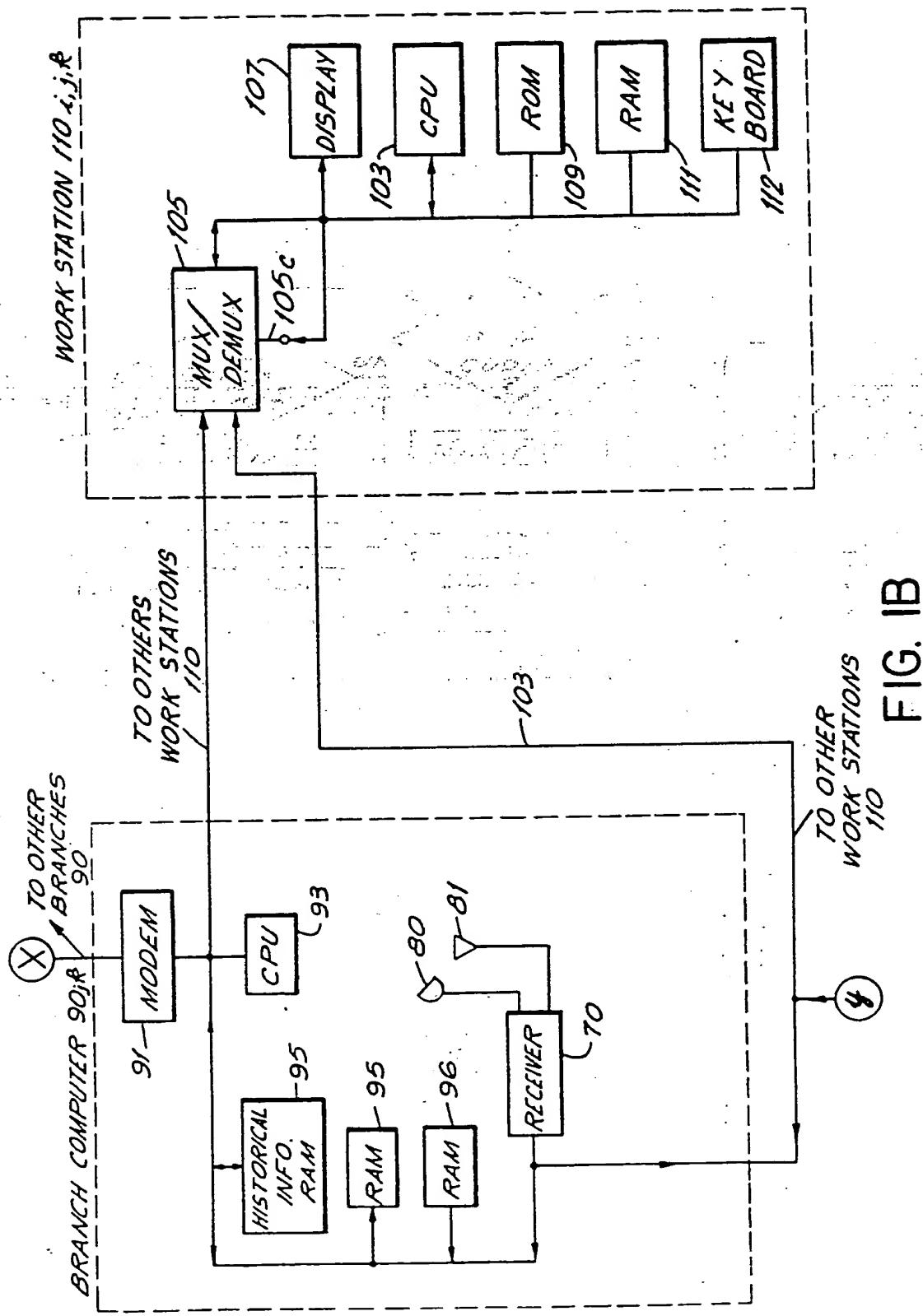


FIG. 1B

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107

142		143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1060	1061	1062	1063	1064	1065	1066	10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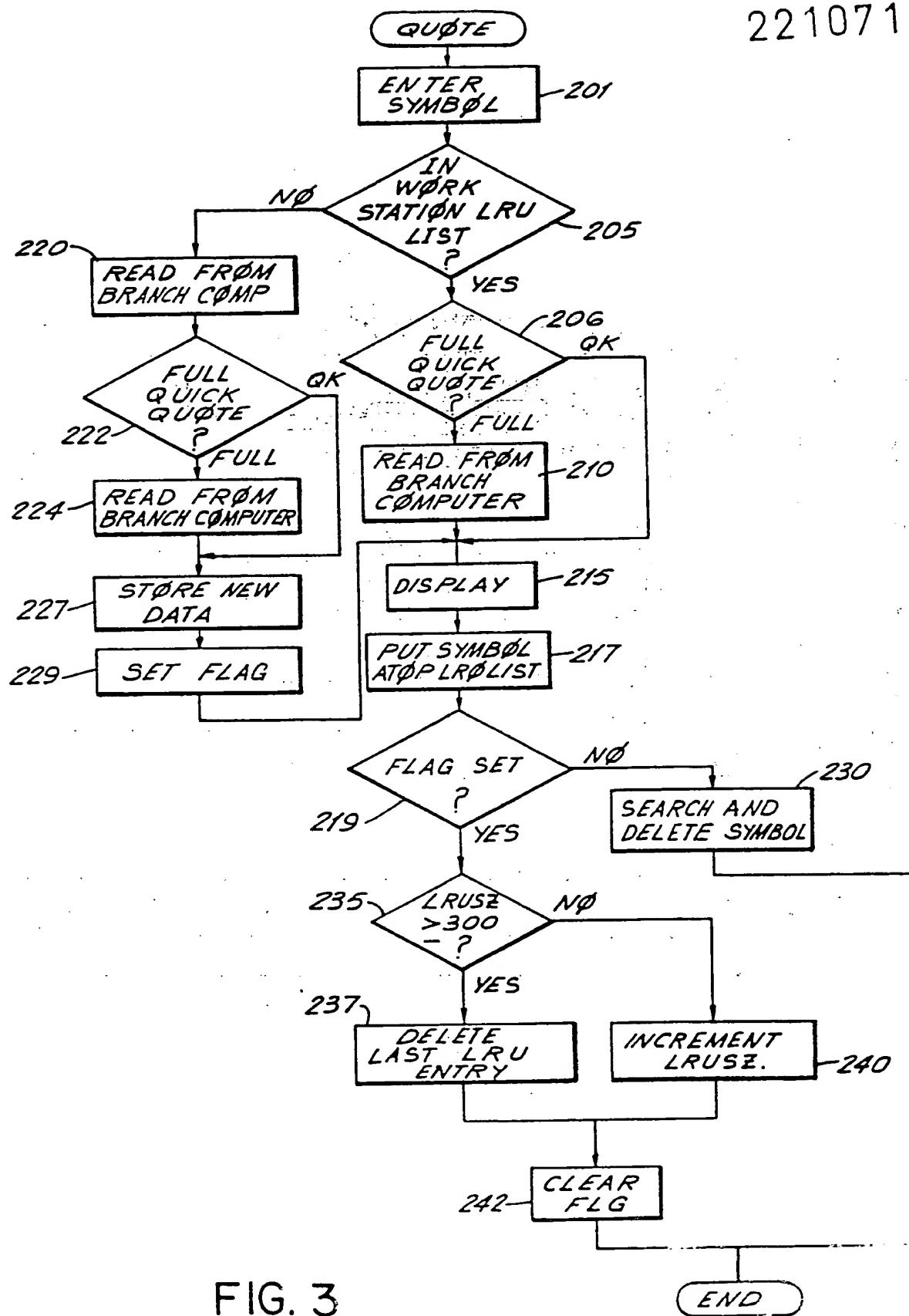
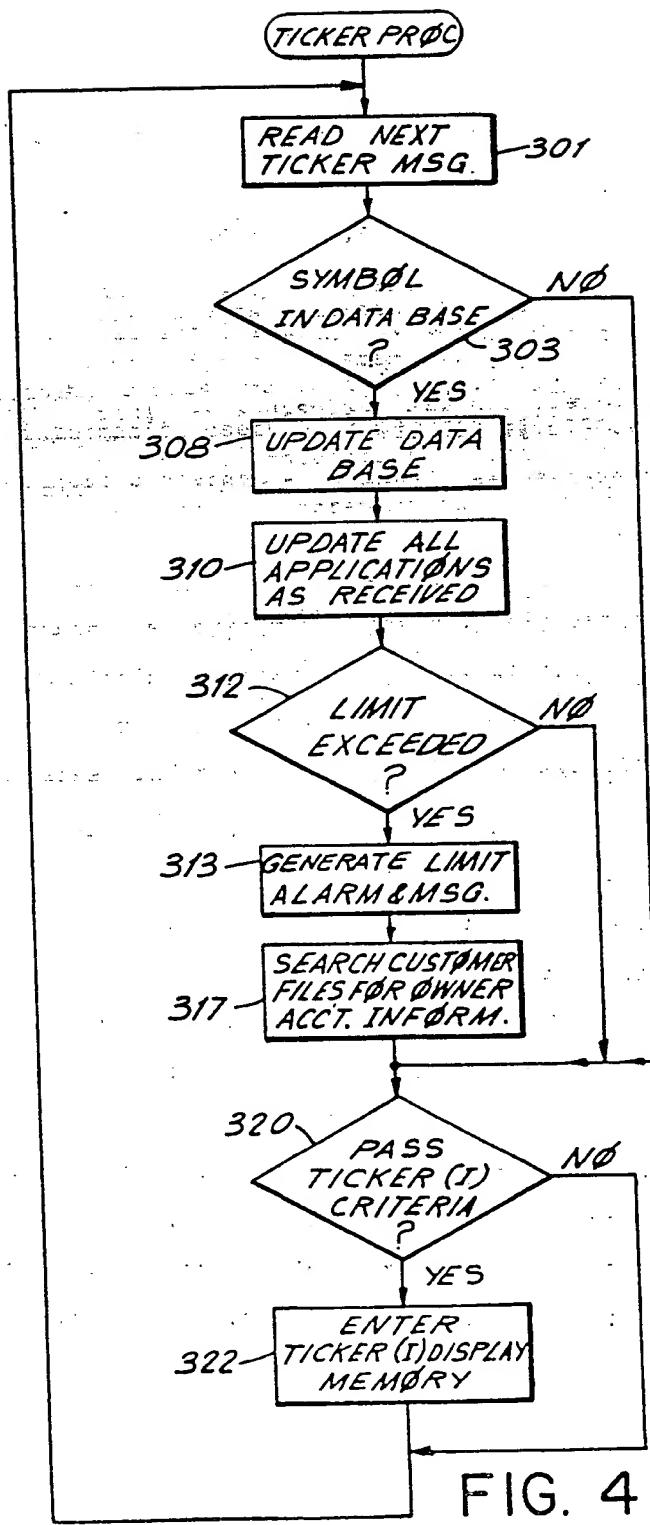


FIG. 3

END

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Disclosure of the Invention

This invention relates to data communication and processing systems and, more specifically, to a system for distributing, processing and displaying financial market data, news and the like.

It is an object of the present invention to provide improved user friendly apparatus for communicating, storing, processing and displaying financial market information, news and other original and derivative data.

More specifically, it is an object of the present invention to provide apparatus and methodology to communicate and display information useful for securities brokers, investors, and others concerned with financial markets; to provide multiple viewing windows to display diverse and/or related ticker and other market information; and which permits interactive user control at system microprocessor governed work stations.

It is another object of the present invention that stored program controlled subscriber work stations in a financial market information communication and display system permit local and immediate access to a dynamically changing sub-population of securities of particular interest; and that full securities data is stored on a hierachal basis at varying system facilities.

The above and other objects of the present invention are realized in a specific, illustrative system for distributing, processing and displaying financial market ticker, quotation, news and ancillary information via a plurality of stored program controlled work stations. Stock trade executions, quotations and other ticker plant information is communicated in parallel to a hierarchy of system data processing terminals,

2

e.g., those located at area, branch and individual work station locations. Storage media at the several system data processing levels extracts and stores data base information of differing purport and completeness for the disseminated data to support the system work station users.

In accordance with one aspect of the present invention, information characterizing a dynamically changing sub-population of the market securities is maintained at and becomes immediately available to each work station responsive to the pattern of usage at that specific station. Various derivative tasks, such as security price limit alerts and customized, selective ticker displays, are user programmable and are actuated by the work station data base.

The above and other features and advantages of the instant invention will become more clear from the following detailed description of a specific, illustrative embodiment thereof presented hereinbelow in conjunction with the accompanying drawing, in which:

Figs. 1A and 1B are the upper and lower portions of a schematic block diagram of a system in accordance with the instant invention for distributing, processing and displaying financial information;

Fig. 2 is an illustrative display presented to a system user via a work station cathode ray tube in accordance with the principles of the present invention;

Fig. 3 is a flow chart illustrating user work station data processing to generate quotation information and to dynamically update the work station data base market security sub-population; and

Fig. 4 is a flow chart illustrating work station ticker and related processing in accordance with the instant invention.

Referring now to Figs. 1A and 1B, hereinafter referred to as composite Fig. 1, there is shown in block diagram form improved communications and data processing apparatus for communicating information characterizing financial markets generated at a central, common location, and for making that information available at a potentially large number of subscriber work stations  $110_{i,j,k}$ , e.g., located on desks of brokerage industry account executives, their customers, and/or others whose business or interest is the world of finance.

Examining the system in overview, each work station  $110_{i,j,k}$  includes a display 107, e.g., a cathode ray tube controlled by a central processor 103. The work station  $110_{i,j,k}$  also includes a program containing memory 109, e.g., a read only (ROM) device and variable content memory 111, e.g., a random access (RAM) unit. The user work station RAM 111 contains a good deal of the data of most interest to the specific work station  $110_{i,j,k}$  user and, in general, the RAM 111 contents vary from user to user. RAM 111 may also contain programs or program portions.

Each work station  $110_{i,j,k}$  has access to information stored in more senior computers in the computer hierarchy of the instant invention. Thus, for example, the broker at the illustrated work station  $110_{i,j,k}$  (and all others similarly situated) has access to his branch computer  $90_{j,k}$  and, in particular, to the variable content RAM memories 95 and 96 there located which supply information beyond that capable of storage in the RAM 111 of work station  $110_{i,j,k}$ . Yet further continuing up the computer hierarchy, the work station  $110_{i,j,k}$  has access to the contents of a RAM 60 in an area-serving computer  $50_k$  with which its branch is

associated. Ultimately, all system work stations 110 can access the master customer data base memory 12 in a home office main frame computer.

The basic data characterizing securities trading is generated in the manner per se well known to those skilled in the art. In particular, trading information (e.g., execution prices and volume, and quotations) are supplied by the New York Stock Exchange 28 to a ticker plant 35. Also supplied to ticker plant 35 is comparable trading information from the several so-called regional exchanges 30<sub>1</sub> through 30<sub>n</sub>. Other, domestic and worldwide information may be included as well. The output of the ticker plant is information characterizing stock trade executions at the respective exchanges, as well as bid and asked quotation information. The output of the ticker plant 35, as presently constituted and per se known, is the ticker of common experience which is distributed typically via land lines to brokerage houses and other financial institutions.

In accordance with the present invention, the ticker plant output is supplied via a microwave uplink 38 for satellite distribution to receive-only earth stations at the area and branch computer locations 50 and 90. For redundant transmission, the ticker information is also radiated on a multiplexed basis with a television program. Such data multiplexing with a television signal is per se well known and may be included, for example, as digital information modulating the video carrier in the vertical retrace interval to not be recoverable by conventional television receivers tuned to the underlying television program. Receiving equipment 70 at the area and branch computer locations 50 and 90 receives the radiated versions of the ticker plant 35 output.

Advantageously for market information continuity assurance, the receiving location apparatus 70 includes antennas 80 and 81 for respectively receiving each of the satellite and television radiated signals. Examining the receiving equipment shown in Fig. 1 for area computer  $50_k$ , illustrative of all such apparatus, the satellite and VHF or UHF television-multiplexed signals are respectively received at antennas 80 or 81 and detected by RF receivers  $78_1$  and  $78_2$ . Antenna surrogates, such as cable television delivery systems, may be employed. A demultiplexer 77 selects the base band data stream output of one or the other of radio receiver/detectors  $78_1$  or  $78_2$  under control of central processor 72 in accordance with any appropriate algorithm stored in a ROM memory 74. Thus, for example, the CPU can receive and temporarily store in a RAM 76 the data stream outputs of both receivers  $78_1$  and  $78_2$  and select that one exhibiting the lower error rate. Other selection algorithms will be readily apparent to those skilled in the art.

The securities trading information is thus coincidentally supplied directly to each of the system branch and area computers 90 and 50 in parallel on an over-the-air, radiated basis. In each area computer 50, e.g., the unit  $50_k$  shown in Fig. 1A, the received trading information is stored by the main central processing unit 56 under control of the program stored in read only memory 57. In the area computer  $50_k$ , which is senior in the computer 50-90-110 hierarchy of Fig. 2, complete market data for substantially the entire population of monitored securities is retained in RAM 60. The functions of elements 72, 74 and 76 could of course be performed directly by elements 56, 57 and 60.

Correspondingly, in a branch computer 90, e.g., the computer  $90_{j,k}$ , variable content RAM memory 96 makes no

5

attempt to store all of the monitored securities. Rather, RAM memory 96 stores information for only a subset of the entire securities population corresponding to those securities which are of generally popular interest. Computer 90<sub>j,k</sub> memory 96 thus retains current market information for a securities population less than that of the area computer 50<sub>k</sub> but substantially greater than that retained in RAM 111 of the work stations 110<sub>i,j,k</sub> associated with the branch 90<sub>j,k</sub>.

As a matter of overall system philosophy, when a work station 110<sub>i,j,k</sub> seeks current price information for a security not then within its memory 111, it seeks such information from its associated branch computer 90<sub>j,k</sub>. If the information is not available at the branch level, the branch computer 90<sub>j,k</sub> inquires of the area computer 50<sub>k</sub> via connecting modems 91 and 52 and communications link 83. Thus a reasonable amount of memory and computing power is employed at the several system hierachal levels commensurate with the reasonable needs of those levels. All information is obtainable at a work station 110 either from its internal storage, from its branch, or from its area. Additional information may be obtained, as needed, from the home office main frame central processor 14 and data base 12 (source level 10) via communications apparatus 22 (e.g., the switched telephone network) and modem 25; or from external data base(s) 26 via a modem 27.

The illustrative branch computer 90<sub>j,k</sub> includes a RAM 95 which stores historical information characterizing securities of interest, e.g., past earnings, price earnings ratio, dividend history, annual high and low prices, and so forth. Such information is available to any work station 110

associated with that branch 90<sub>j,k</sub> via appropriate keyboard 112 entries ("full quote") at the work station. The current stock price information RAM 96 and the historical, corporate information stored in RAM 95 are shown distinct in Fig. 2. The two memories 95 and 96 may of course be separate or commingled portions of a single such memory.

As a final source of information for the system of Fig. 1, one or more source level 10 news wire source(s) 24 supply financial news via land lines 25 to the various area and branch computers 50 and 90 and, via the branch computers, to the various work stations 110. Illustrative of currently available news wire sources are those provided by Dow Jones and Reuters.

Alternatively, the news information furnished by source 24 can be multiplexed and radiated with the output of ticker plant 35 for distribution to area, branch and work station computers.

It is an objective and purpose of the instant invention to make use of the market and news information generated by ticker plant 35 and news wire source(s) 24 at the various system work stations 110. That is, the work stations 110 have a signal entry keyboard 112 which may be employed by a user (e.g., a broker) to specify various kinds of information desired for viewing via his display 107. As above noted, part of the market information resides within his work station in RAM 111. Additional quotations not already at his location are loaded via multiplexer/demultiplexer 105 under central processor 103 control via multiplexer control port 105<sub>c</sub> from the associated branch computer 90 or area computer 50. The information presented at display 107 may comprise a single field of information, e.g., a quotation, a ticker flow or the like. Alternatively, in accordance with one aspect of the instant

invention, a multi-window display may be presented via the cathode ray tube 107. Moreover, depending upon the user-entered key strokes, the specific format of the multi-window display may vary. Presenting plural "windows" or fields on a single cathode ray tube display is of course per se well known to those skilled in the art and is available via IBM, Bell Laboratories and others.

One illustrative multi-window presentation for display 107 at a system work station 110 is shown in Fig. 2. The composite presentation has a first field 142 which simply comprises the complete New York Stock Exchange ticker (a series of stock transaction messages for stock executions on that exchange). The field includes a sequence of messages each formed of a stock symbol 143 followed by the volume (in hundreds of shares) 144 and the trade price 145. The price 145 may have its first digit deleted, and volume may be omitted on reasonably busy days to obviate undue ticker delays. Examining, for example, the first trade constituent in the ticker data field 142 in display 107, one viewing the ticker would know that 5,000 shares of the security having an exchange symbol ABC traded at a price of 90 3/4.

The multiple window display format chosen by the user via keyboard 112 includes a second ticker ("TICKER-2") specified under the user control. In accordance with varying aspects of the present invention, the user may format his own personal ticker by establishing criteria which a trade message from ticker plant 35 must satisfy to pass to the TICKER-2 window field 147 for viewing. The criteria, stored in RAM 111, may specify trades in only a specific enumerated list of securities, trades from specific exchange(s), and/or so forth.

This gives rise to a relatively slow speed, focused ticker which eliminates the clutter associated with trading of securities of no interest to the operator of the specific work station 110.

A display field 149 forms a scrolling presentation of the news reported via the source 24; and a field 151 in the particular display format shown contains limit-exceeding information. The entry illustrated in Fig. 2 identifies a security (MNO) which has last traded (25 5/8) outside (lower) a bound (25 7/8) stored in RAM 111. Upside and downside limits are often used by brokers and investors as buy or sell conditions and are of interest both to the broker and to his customers owning those securities.

A further, MONITOR field 153 contains price information for a predetermined population of securities of interest to that particular broker. Each entry includes an identification 154 (the stock symbol), a designation 155 of the market where the last trade occurred, an arrow 157 signalling whether the last trade was an uptick or downtick, and the currently obtaining bid and ask prices 158. Finally, a QUICK-QUOTE field 157 provides a quotation for a particular stock (ABC) having a symbol entered by the user via keyboard 112. Reading across the illustrative entry of Fig. 2, the stock symbol is followed by an identifier for the exchange executing the last trade (New York) in the security, an arrow showing the tick direction of the last trade (up), the trade price (90 3/4), the current bid (90 5/8) and asked (90 7/8) prices and the exchanges where those bid and ask prices came from (bid-Boston and New York, asked-American and Toronto), the bid and ask volume sizes (60 and 5 respectively), the number of shares (230,800) of that

security traded so far during that business day, and the time of the last trade (12:02).

Other windows in addition to or superimposed upon the display of Fig. 2 may be employed as well. Thus, for example, a field may signal the operative stored securities limits as just one example among many.

Each of the data fields in Fig. 2 may be displayed, alone, on the face of the cathode ray tube under user control entered via the keyboard 112. Alternatively as above discussed, one of various multi-window formats may be specified via the keyboard 112, as again is per se well known, to present a number of data fields simultaneously.

As alluded to above, it is one of the offices of the instant invention to store within each work station 110<sub>i,j,k</sub> and in particular in the RAM memory 111 there located, information characterizing the securities of interest to that broker or other work station user. To that end, the stored computer program automatically stores in the variable content RAM memory 111 of the subject work station securities identification and price data corresponding to a limited, predetermined number (e.g., 300 for purposes of specificity only) of securities whose price information was last requested at that work station. When the station 110 is at its upper storage limit (300), a new quotation request automatically causes the central processor 103 to discard the oldest security in the limited stored population, i.e., the one last viewed prior to later quotation requests for 300 different securities.

As new trades in the monitored 300 security population are reported via the ticker plant 35, communications link receiver 98, demultiplexer 105 and work station central processor 103

automatically change the stored price information in RAM 111. The stored security price information also automatically changes the price presentation for the respective securities wherever a security appears in any of the multiple windows (fields) of the display 107. That is, new price information for any particular stock will change in each window in which that security appears. For example, a price change in the price of the equity whose symbol is assumed to be ABC for the illustrative display of Fig. 2 causes changes in at least the MONITOR field 153, the NYSE Ticker 142, and in the QUICK-QUOTE field 157 all of which derive their refreshed information from the work station data base in RAM 111. If the last trade exceeded a limit, an appropriate message would be generated as well in field 151.

Attention will now be directed to the flow chart of Fig. 3 which presents the operative program for maintaining the data base in the work station 110 RAM 111 to reflect the limited (300) entries most recently queried at that specific work station. The program for dynamically controlling storage at the user's work station 110 is typically stored in the read only memory, or ROM 109 there included although RAM 111 storage is also possible. To reiterate, it is the function of the dynamic storage algorithm to maintain in the variable, RAM memory 111 at the user's station 110 information associated with the 300 securities for which quotations were most recently requested at that station (and which are thus most likely to generate future quotation requests). To this end, RAM 111 includes a "least recently used" or LRU list which stores the stock symbols of the most recently requested 300 (or fewer) securities. It will be assumed that the most recently

requested security resides in the top, or first position, in that list; and that the least recently requested symbol is stored at the bottom of the list in a jeopardy position to be purged if a new security, not otherwise in the LRU list, is entered at the work station keyboard 112 (assuming a full complement of 300 items). A processing variable LRUSZ is maintained to indicate the size or number of items in the LRU list. Programming for the instant invention may of course be in any convenient language which is stored and implemented on any of the diverse forms of digital processing apparatus.

To illustrate specific operation of the dynamic storage reallocation algorithm, assume that a broker or other user at the work station 110<sub>i,j,k</sub> illustrated in Fig. 1B wishes a quotation on any desired security. He enters the corresponding symbol for the security as by his signal entry keyboard 112 (functional step 201 in Fig. 3). Test 205 then examines the LRU table to determine whether the newly entered stock symbol is already in the LRU list. If it is (YES output of test 205), test 206 examines the command message entered through keyboard 112 to determine whether the user wishes a full quote (e.g., including historical and derived (e.g., price-earnings ratio) information not locally available at the work station 110 or the more common so-called quick quote price and volume information which is locally available. If a full quote is desired, the work station 110 obtains the historical information from the historical information memory 95 in the branch computer 90<sub>j,k</sub> via the communicating demultiplexer 105. If desired, historical information of varying levels of detail may be distributed between the branch and area RAMs 95 and 60. In either event, either the quick quote or full quote

after data retrieval from RAM 95 is displayed for the user (step 215) as via the user's cathode ray tube display 107.

Tracing the alternate output path from the test 205, assume that the stock symbol requested was not one recently examined at the specific work station 110<sub>i,j,k</sub> and therefore was not in the LRU list locally available from the work station 110 RAM 111 (No output path of test 205). When this condition obtains, the desired quotation is retrieved from the branch RAM 96 (or higher order computer if necessary) - step 220. Depending upon whether a full quote or quick quote was specified by the input command entered by the user at keyboard 112, test 222 fetches the full information from the branch RAM 95 if appropriate (step 224) or skips this operation if only a quick quote was desired. The following operation 227 stores the securities information just obtained in the user's work station variable memory 111, and step 229 sets a flag bit in some predetermined location (e.g., FLAG) to signal that Fig. 3 processing is dealing with a security not previously stored at the user's work station 110 memory 111. As before, the quotation information is displayed in its full or quick (limited) form in the display step 215.

Following delivery of the information to the user's display 107, the symbol for the security just requested by the user is put on top of the LRU list which signals that this security was most recently requested at the work station 110<sub>i,j,k</sub> (step 217).

The remainder of the functional operation depicted in Fig. 3 then serves to maintain the least recently used (LRU) list in correct form as well as to maintain the list size variable (LRUSZ) at the correct value. To this end, test 219 examines

the contents of the flag bit (FLAG) to determine whether or not the symbol most recently processed was new to the data table (it being new following the NO output of test 205 but not for the YES output of that test). If the flag bit was not set (NO output of test 219) signalling that the stock symbol (and its concomitant information) was already in the LRU list and in the RAM 111 data table, step 230 searches through the LRU list after position 1 and deletes the second appearance of the symbol in the list. The symbol is deleted since it is known to be in the first or most senior position in the LRU list as a result of step 217 and thus its redundant presence is discarded. That completes operation of the Fig. 3 dynamic storage reallocation for the assumed branch of data processing which thus goes to the end point of the subroutine and passes to system control for other system business.

When test 219 signals that the flag bit was set (YES output signalling that the symbol was new to the LRU list) test 235 next determines whether or not the LRU list is at its maximum size ( $LRUSZ \geq 300$ ). If it is not, the data table can accept a new symbol without deleting an old one. Accordingly, the LRU size variable is incremented by one ( $LRUSZ = LRUSZ + 1$ ) in step 240, the flag bit is cleared (step 242), and processing is completed. Correspondingly, if the LRU table is full (YES output of test 235), the bottom element in the LRU list is deleted (step 237). The flag bit is then cleared (step 242) ending the routine.

Accordingly, the Fig. 3 mode of data processing automatically maintains within the work station 110 RAM 111 a list (LRU) of the 300 most recently requested stock symbols at that station. The newer of the stock symbols requested are in

the top portion of the list while the older symbols are in the bottom part of the list, with symbols being deleted if they are not requested a second time before 300 other quotations are entered at the user keyboard 112.

It will be apparent that the stock symbols in the LRU list and the corresponding stock price values and other information, will vary from time to time for any user of the equipment 110, and will differ at any given time for different system work stations presumably having operators who enter different patterns of quotations. The local variable memory 111 of each work station 110 will thereby store the information most likely to be next needed by each station user and which will be quickly available to that person, not requiring interrogation (other than for "historical" information) from any other system computer thus obviating communication and possible queueing delays.

Finally, attention will be directed to the flow chart of Fig. 4 which presents the operative program for dynamically updating data in the user's RAM 111 data base characterizing the stocks having a present application for that user. That is, Fig. 4 depicts the manner in which current price and other market data is loaded into the user's RAM 111 to provide current information for each component of the display (Fig. 2) of the user's cathode ray tube 107. It will be assumed for simplicity of discussion that each separate display application (Fig. 2 field or window) has an associated list in RAM memory 111 of those symbols currently of interest, i.e., there exists a first list (LRU table) for the 300 most recently requested quotations; a second list for those securities for whom limits are being maintained, further lists for the ticker

presentations, and so forth. Each list would contain or have a pointer to all data for each security in that list.

Alternatively, a single integrated list and data table may be employed for all stocks for which there is any current application, together with one or more identifiers which record those application(s) for which the stock data is required.

Examining the flow chart of Fig. 4, the first step 301 reads into the computer CPU the next incoming stock symbol, price, volume and related information (ticker message) originated by ticker plant 35, and furnished to the work station 110 via its corresponding branch apparatus 1,2,k 70,80,81 via cable 103 and demultiplexer 105. Test 303

examines each of the application stock lists (i.e., the LRU list, the list associated with the limit processing, and so forth). If the security being characterized by the ticker plant message is not in any such list (No output of test 303), control passes to test 320 to determine whether or not the stock data is appropriate for one of the tickers (e.g., 142 or 147 of Fig. 2) in the user display. Assuming that the trade information being reported by ticker plant 35 is germane to one or more of the applications for that specific work station 110, the data base in RAM 111 associated with that security is updated (step 308) to reflect the last trade and quotations for that stock and step 310 updates all applications (windows and the related window-driving storage) associated with that stock as necessary. Thus, as only one example and assuming that the stock having the trade information then being reported by the ticker plant was in the LRU list and data base, the information being reported replaces the older data for that security stored in the data base of the user's RAM 111.

Assuming the stock to be one maintained in the limit table (supporting display field 151 of Fig. 2), test 312 determines whether the trade being reported exceeds any limit bound. If it does not (NO output of test 312), system control passes to test 320 for ticker processing. If a limit is exceeded (YES output of test 312), a limit-exceeding message appears in the field 151 of Fig. 2 advising the user of the appropriate circumstances. It will be readily apparent that a price may be tested against upper and/or lower bounds as desired for the investment strategy of the user, or of the customers of the user. In addition, step 317 recalls from the master customer data base 12 via multiplexer 105 the branch modem 91 and all remaining communication apparatus intermediate the data base 12 and work station 110 the name, account number, telephone number and all other desired information for all customers who hold the security for which the user's station has indicated an out-of-limit message. As appropriate the user may contact each such owner of the subject security to determine if any action is desired or to take such automatic action as may be appropriate.

Finally, test 320 examines the subject ticker plant 35 message to determine whether or not it is appropriate under the criteria established by the user at his work station 110 for either of the ticker streams 142 or 147 being displayed. If the criteria is satisfied (YES output of test 320) the message is added to the appropriate ticker display memory or memories for entry into the appropriate ticker. The ticker criteria as above noted is subject to definition by the user. If the user has limited a ticker to a finite group of stocks, the ticker criteria is satisfied if and only if the stock symbol in the

incoming message matches a stored desired symbol. Other criteria will be readily apparent, e.g., to display only trades from a particular exchange (part of the data transmitted by ticker plant 35). If the ticker plant message is not appropriate for display on any ticker (No output from test 320), control passes to the beginning of Fig. 4 processing to await the next trade quotation being supplied by the master ticker plant 35 (or to shift to other system functions).

Fig. 4 processing thus serves to maintain the data in the user RAM 111 current with respect to each of the applications then contemplated by that unit, and to also limit the data shown on the display tickers to that information which the station 110 user wishes to receive. The composite apparatus of Figs. 1A and 1B operates flexibly to monitor and display only that information which each work station 110 user wishes stored and displayed and to provide rapid access to a limited portion of the very large mass of securities data which serves the particular user pattern and personality of each work station operator, providing rapid access to information which that user is most likely to require.

The above-described apparatus and methodology is merely illustrative of the principles of the present invention. Numerous modifications and adaptations thereof will be readily apparent to those skilled in the art without departing from the spirit and scope of the present invention.

WHAT IS CLAIMED IS:

1. In combination in financial information dissemination, processing and display apparatus; plural digital processing work stations, each of said work stations including display, central processor, memory and signal entry means, said memory means including plural storage elements for storing data characterizing a sub-population of the population of investment securities; ticker source means for serially furnishing current trade information messages for the population of investment securities in parallel to said central processors of said work stations; said central processors of each of said work stations operatively selecting data received from said ticker source means corresponding to said stored security sub-population and for updating the data in said memory means for said stored security sub-population.

2. A combination as in claim 1, further comprising additional memory means, means coupled to said ticker source means for storing in said additional memory means data characterizing substantially the complete security population, and means connecting said additional memory means with said work stations.

3. A combination as in claim 1 or 2, wherein said memory means in at least one of said work station means stores a security sub-population of predetermined size, means responsive to quotation requests entered via said signal entry means for extracting and displaying via said display means data

characterizing said security sub-population retrieved from said memory means if there located or, if not so located, from said additional memory means, and means for dynamically maintaining in said stored securities predetermined sub-population in said memory means data for said predetermined number of most recently quoted securities of said population entered via said signal entry means.

4. A combination as in claim 1, wherein said memory means of at least one of said work stations includes means for storing a securities identifier and at least one range bound therefor, and wherein said central processor means includes means for displaying an indication when a received ticker message for a monitored security has a trade price component which falls outside a stored range bound therefor.

5. A combination as in claim 3, wherein said memory means of at least one of said work stations includes means for storing a securities identifier and at least one range bound therefor, and wherein said central processor means includes means for displaying an indication when a received ticker message for a monitored security has a trade price component which falls outside a stored range bound therefor.

6. A combination as in claim 2, wherein said additional memory means includes a hierarchy of additional storage apparatus each containing data characterizing a monotonically larger proportion of said population of investment securities.

7. A combination as in claim 1, further comprising a customer data base, and communications means selectively coupling each of said work stations with said customer data base.

8. A combination as in claim 1 or 4, further comprising additional data processing means including additional memory means, said additional data processing means including receiver means for receiving serial data supplied by said ticker source means, means for storing in said additional memory means data characterizing a substantially larger number of said investment security population than said work station memory means, and means connecting said additional data processing means with plural of said work stations.

9. A combination as in claim 2, 6, or 8, wherein said additional memory means includes historical financial data for said securities population.

10. A combination as in claim 8, wherein said ticker source means includes transmitting means for providing over-the-air transmission of said current trade information, and wherein said ticker receiver means in said additional data processing means includes means for recovering the current trade information transmitted by said ticker source transmitting means.

11. A combination as in claim 10, wherein said transmitting means of said ticker source means includes means for radiating said current trade information on two redundant

channels, and wherein said current trade information receiver means of said data processing means includes means for selecting for reception one of said two redundant transmission channels.

12. In combination in financial information dissemination, processing and display apparatus; plural digital processing work stations, each of said work stations including display, central processor, memory and signal entry means, said display effecting a coincident presentation of at least one formatted ticker and plural data fields, said memory means including means for storing acceptance criteria for each ticker display and means for storing data characterizing a sub-population of the population of investment securities sufficient for all securities included in said plural data fields; ticker source means for furnishing current trade messages for the population of investment securities to said central processors of said work stations; said central processor of each of said work stations including means for operatively selecting data received from said ticker source means corresponding to said stored security sub-population and for updating the data in said memory means for said stored security sub-population, and said central processor of said work stations further including means for extracting acceptance criteria from said memory means, means for comparing each received current trade message from said ticker source means for selectively displaying at least a portion of said received message in said ticker display.

13. A combination as in claim 12, further comprising additional memory means, means coupled to said ticker source

means for storing in said additional memory means data characterizing substantially the complete security population, and means connecting said additional memory means with said work stations.

14. A combination as in claim 13, wherein said memory means in one of said work station means stores a security sub-population of predetermined size, means responsive to quotation requests entered via said signal entry means for extracting and displaying via said display means data characterizing said security sub-population retrieved from said memory means if there located or, if not so located, from said additional memory means, and means for dynamically maintaining in said stored securities predetermined sub-population in said memory means data for said predetermined number of most recently quoted securities of said population entered via said signal entry means.

15. A combination as in claim 12 or 13, wherein one of said data fields signals an out of limit price for one of said population of securities, wherein said memory means of said work stations includes means for storing a securities identifier and at least one range bound therefor, and wherein said central processor means includes means for displaying an indication when a received ticker message for a monitored security has a trade price component which falls outside a stored range bound therefor.

Amendments to the claims have been filed as follows

1. Financial information dissemination, processing and display apparatus comprising ticker source means for furnishing current trade information messages for the population of investment securities and a multilevel hierarchically connected system of data processing stations wherein the different system levels are characterized by different capabilities for storage of investment securities data, said system of data processing stations including, at an upper level of the hierarchical system, means coupled to said ticker source means and storing data characterizing substantially the complete investment securities population and, at a lower level of the system, a plurality of digital processing work stations, each of said work stations including a display, a central processor, signal entry means, and memory means including plural storage elements storing data characterizing only a sub-population of said population of investment securities, said upper level means coupled to the ticker source means being connected with each of said lower level work stations for furnishing current trade information messages

received from said ticker source means in parallel to the central processors of said lower level work stations, said central processors of said lower level work stations each being programmed to be responsive to said messages by operatively selecting data received from said ticker source means and corresponding to its respective stored securities sub-population and updating the data in its respective memory means for said stored securities sub-population, and each of said lower level work stations being responsive to quotation requests entered via its signal entry means and relating to securities included in its own stored securities sub-population by extracting and displaying via its display means data from its own memory means characterizing its stored securities sub-population and furthermore being arranged to be responsive to other such quotation requests relating to securities not included in its own stored securities sub-population by accessing the higher levels of the hierarchical system and retrieving the relevant data therefrom and displaying the same via its display means.

2. Apparatus as claimed in claim 1, wherein said memory means of at least one of said work stations includes means for storing a securities identifier and

at least one range bound therefrom and wherein said central processor of the respective work station includes means for displaying an indication when a received ticker message for a monitored security has a 5 trade price component which falls outside a stored range bound therefor.

3. Apparatus as claimed in claim 1 or 2, wherein said multilevel system of data processing stations includes a hierarchy of storage apparatuses containing 10 at successively higher levels of said system data characterizing a monotonically increasing proportion of the complete population of investment securities.

4. Apparatus as claimed in claim 3, wherein the data processing stations at each level of the multilevel system above said work station level include memory 15 means and data processing means including receiver means for receiving data supplied by said ticker source means.

5. Apparatus as claimed in claim 4, wherein the 20 memory means of at least one upper level of the multilevel system stores historical financial data for said securities population.

6. Apparatus as claimed in claim 4 or 5, wherein said ticker source means includes transmitting means for providing over-the-air transmission of said current trade information, and wherein said ticker receiver means in the upper level data processing stations includes means for recovering the current trade information transmitted by said ticker source transmitting means.

10 7. Apparatus as claimed in claim 6, wherein said transmitting means of said ticker source means includes means for radiating said current trade information on two redundant channels, and wherein said current trade information receiver means of said data processing means includes means for selecting for 15 reception one of said two redundant transmission channels.

20 8. Apparatus as claimed in any preceding claim, further comprising a customer data base, and communications means selectively coupling each of said work stations with said customer data base.

9. Apparatus as claimed in any preceding claim wherein said display included at each of said work stations is arranged for effecting a coincident

presentation of at least one formatted ticker and plural data fields, said memory means of each said work station includes means storing acceptance criteria for each ticker display and means storing data characterizing a sub-population of the population of investment securities sufficient for all securities included in said plural data fields, and said central processor of each said work station includes means extracting acceptance criteria from said memory means and means comparing each received current trade message from said ticker source means and selectively displaying at least a portion of said received message in said ticker display.

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